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ABSTRACT

This paper presents a model which incorporates traditional art skills into the high school science classroom. Science, art and English teachers are provided with a scheme by which science works can be incorporated into art or English classes and literary and art analysis skills can be applied in the science class. Using this model, students read, analyze, critique, and investigate the presentation of scientific information in literary works, and they use artistic skills to present their observations or interpretations of scientific phenomena. Based on these works, scientific information is organized into a variety of formats, both the traditional science report and non-traditional creative arts products such as essays, videos, poems, photographs, and drawings. A lesson plan based on the Robert Frost poem "Design" is provided which demonstrates essential aspects of the analysis and assignment scheme, along with examples of student products. Four appendices consist of: Virginia Department of Education Standards of Learning Program Goals and Objectives; extended questions for the "Design" lesson plan; a sample lesson plan utilizing a "Walden" selection; and (4) a reading list and samples of student art products. (LL)

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A MODEL FOR INTEGRATING NON-TRADITIONAL SKILLS AND INSTRUCTION FROM LITERATURE AND ART INTO SCIENCE CLASSROOM ACTIVITIES

BY

CHARLES K. JERVIS

"Most science teachers I know do not think of writing as an important part of their class." (Johnston in Gere, p.92,1985)

These words reflect a common opinion of science classes. Most English teachers do not think of science as an important part of their classes either. The same can certainly be said for mathematics, history, foreign languages teachers or art. At the high school level, most teachers do not normally think of other classes as relating to their own classes. True, science teachers and mathematics teachers share common goals in some of the applications of some of their material. Additionally, health teachers and biology teachers, English teachers and drama teachers, or physics teachers and industrial arts teachers often share common goals for student performance. However, rarely do English teachers and science teachers or art teachers and science teachers share common goals and techniques.

There are numerous examples in the literature which deal with scientific writing or art work which has a scientific nature, most commonly scientific illustration. Many publications offer information concerning improving science students' writing and reference books are available which can be used to instruct in scientific illustration. However, many of them are like Hamilton (1978) or Flynn (in Young, 1986) which present a series of steps to use in making good science writing into good English writing or which present mechanical drawing or technique as the way to incorporate art into the science classroom. These are sometimes rather mechanical approaches to improving writing. Others discuss ways to present technical topics in non-technical ways. A

particularly good one is Anderson et al (1987) which explores exercises in which students develop skills at using non-scientific metaphors to present scientific topics. This clearly demonstrates Bronowski's sentiments, expressed in Science and Human Values, concerning the use of metaphors and symbols in science as being just as necessary as they are in poetry.

As teachers we are involved in educating the whole child. In the process of doing this we are responsible for integrating the whole curriculum. Thus, the student is given opportunities to incorporate skills and techniques from one course into other courses. This paper presents a model with which traditional art skills can be incorporated into the science classroom. Also, it presents to science, art and English teachers a scheme by which science works can be incorporated into the art or English class and by which literary and art analysis skills can be applied in the science class. In the process this technique will help students develop as writers and readers of both scientific and non-scientific materials.

This incorporation is not necessarily a new or innovative one. For centuries people have been successfully combining the arts and sciences into unified products. Among some renaissance thinkers, the divisions between art and science were never deep, if they existed at all. The works of Leonardo DaVinci, Francis Bacon, Thomas Jefferson, or Benjamin Franklin reflect a type of universality of thought which merges scientific, artistic, and literary processes. In fact the term "renaissance man" describes a person who incorporates a broad based outlook into his approach to the world. In response to post-industrial age demand for factory trainable and technically adept workers, educational schemes deemphasized broad based arts and sciences and a classical liberal arts education. However, many contemporary intellectual leaders still reflect the earlier eclectic attitudes demonstrated by DaVinci, Bacon, Jefferson, and Franklin. These individuals are usually better known for one of these areas, art or science, but not well known for both.

Several contemporary authors demonstrate the integration of multiple disciplines. Chief among these are J. Bronowski in The Abacus and the Rose and W. Beveridge in The Art of Scientific Investigation. Additionally, literary studies frequently include works concerned with the aspects of the natural world from possible scientific points of view. For example,

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Whitman's "When I heard the learn'd astronomer", Thoreau's Walden and Plath's "Mushrooms" are often included in English class literary studies. The scientific aspects of such works are infrequently considered. Just as infrequently are such works considered in science classrooms. However, the artistry and beauty of literary composition are not lost on contemporary writer/scientists such as Carl Sagan (Cosmos), Jonathan Miller (The Body in Question), or Stephen Gould in his collections of essays from "Natural History" magazine.

Using this model, the students read, analyze, critique, and investigate the presentation of scientific information in literary works. They will use artistic skills to present their observations or interpretations of scientific phenomena. Using these works as models, they organize their scientific information into a variety of formats, both the traditional science report and non-traditional creative arts products. They produce works such as essays, videos, poems, photographs, drawings, and scientific reports. This gives them the opportunity to apply whole language writing process skills in ways not usually associated with science classes.

This sample lesson plan is based upon the lesson plan guidelines presented in the Montgomery County (VA) Public Schools Lesson Plan Model. It demonstrates essential aspects of the analysis and assignment scheme which I have found to be successful in my classes. The poem by Robert Frost, "Design", is a fairly short assignment which can be quickly and easily completed.

A Sample Lesson Plan

Title: Science in a poetic analysis

Readings: Frost, R. "Design"

Focus for Learning: Analyzing, in detail, a literary work for its scientific content.

Statement of Objective: The students will analyze a short literary work in terms of its scientific content. Using this work as a model, the student will produce an original work incorporating science in an artistic way.

Direct Teaching Plan: Have the students read the poem and prepare a summary report of its scientific content according to the following guiding

questions or those in the study guide:

1. What type of mimicry does the spider exhibit ? How do you know ? Identify the components.
2. What type(s) of symbiosis is (are) exhibited by the organisms in this poem ? Identify the components.
3. What types of animal behavior can you infer from the content of this poem ?
4. Propose possible scientific hypotheses to the questions asked in lines 9-12. Design a possible experimental procedure which could test one of the hypotheses.

Checks for Understanding: Discuss, as a group, the interpretations of the scientific content of the poem. Have the students prepare a poem of their own in which they present a scientific topic in poetic terms. The group will analyze the products for scientific accuracy and comment of the poetic value.

Practice Assignment: Students will select another poem and analyze it in terms of the scientific content.

Summary Activities: In group discussions, students will examine the practice assignment results and the products produced in the checks for understanding.

Anticipation of Next Activity: We have been examining literary works for the scientific content they contain or to which they refer. We now will begin examining some scientific communications, hard and soft science, in terms of their literary style and value. In preparation for the next lesson, read the passages listed in Miller's The Body in Question.

To illustrate the checks for understanding and answers to additional questions which appear in a supplemental study guide (see appendix II), a sample student product is given below:

1. The leaves of the plant are meshed together at the base but open at the front, resembling a shell or lips. These would provide excellent cover for the spider. The heal all plant is also a very common plant which flourishes from May to October. [This indicates a knowledge of the morphology and floral ecology of

the plant.]

2. He probably climbed up the plant stalk to the petals. [This indicates a knowledge of animal dispersal mechanisms.]

3. The moth probably couldn't see the spider or web because they were both camouflaged on the white plant. [This indicates a knowledge of protective coloration as a means of food gathering.]

4. Spider webs are made of sticky liquid or liquid silk. [This indicates a knowledge of spider prey capture mechanisms, at least for web builders.]

5. NO, only until man or another larger object or weather tears them down.[This indicates a knowledge of web mechanics and environmental interactions.]

6. YES, the spider kills the insects, like aphids, that might feed on the plant. [This indicates a knowledge of symbiotic mutualism.]

7. The white spider chose the white plant so it could remain hidden and catch more food. The white spider is camouflaged on the plant. [The word "chose" in the answer may indicate anthropomorphism, a topic which needs to be further discussed. It also again reflects a knowledge of protective coloration.]

8. YES, the moth is also white and probably thought he could find food, shelter (hiding place) on the white plant. [The word "thought" may indicate more anthropomorphism, but the answer does indicate some knowledge of moth behavior.]

9. NO, because the animals and other creatures are designed to use all the environment for their benefit, such as survival of the fittest. [The word "designed" here may indicate problems in the more basic concepts of evolution, biogeochemosynthesis and creationism.]

10. Mimicry in this poem are the white spider and moth along with the white plant, the plant has been copied. [Good concise answer.]

11. The spider has a definite mimicry. His color is patterned to blend with the plant. [Good concise answer.]

12. The symbiosis between the spider who gets a home (the flower) and protection from the plant and the plant gets protection from harmful herbivores. [Ignores the broader definition of symbiosis.]

13. Animal behaviors shown are predator/prey.
[Ignores pollination behavior and the larger picture of plant behavior.]

and the following poem was submitted in response to the assignment:

Rain falls upon cold rocks
Drops chip away tiny blocks
Grains of quartz, sheets of slate
Break away at a slow rate.
The stones that are worn away
Will become a farmer's soil one day.
Running water changes land
Canyons, ruts, and gullies bland.
New forms are made a stately way
Through a process called
Erosion.

Both were submitted by Suzanne Shelburne, a student in sixth period biology class at Auburn High School, 1989-1990. David Smith was her partner in the question analysis section of the report. Both submissions were discussed in small groups with certain aspects brought to the class for discussion, concentrating on the scientific accuracy of the answers to the study guide questions.

From an artistic point of view, the works can be interpreted as models of observations or syntheses of observations. In accordance with the descriptions given in the American Association for the Advancement of Science's Science for all Americans and the Virginia Standards of Learning, modeling can be done either by derivation of a formula such as F=ma, sculpture such as a three dimensional space filling model of a molecule, development of conceptual schemes such as viewing the heart as a pump (discussed at length in Jonathan Miller's book, The Body in Question) or in drawing. In drawing, art and science skills can be integrated.

In science, illustration by drawing can be expository, in that it simply records what is observed. This is the way that illustration is most often approached in science. However, it can also be interpretative and represent the impression of what is seen, or a synthesis of a number of observations which communicate the events observed. As examples, shown below are several illustrations which student shave done in biology classes. They represent behavior actions such as those involved in egg dispersal, positive and negative phototaxis, and a survey of organisms observed on a field trip.

The success of the works in art are evaluated in a number of ways. In some instances there are specific rubrics which require that standard aspects of the observations be included. In other instances, peer reviews, self assessment, and public evaluations take place. At times, the art works are placed in an exhibit, either for public comment or as part of a juried art competition.

Teachers who are more taxonomically or systematically inclined may prefer asking students to include correct scientific identification of the organisms involved. Also, more ecologically minded individuals might ask for distributional patterns or mechanisms which the poem or art work implies. The types of information conveyed by a particular "non-scientific" work depends, of course, upon the work. The types of information requested by the teacher depends also upon the teacher's emphasis. As with science, in this literary exercise teachers are encouraged to EXPERIMENT. Certainly additional lesson plans and additional examples of materials which can be used are possible. Using these as guides I hope that other teachers, in all disciplines, will work toward this multi-discipline integration into their own classrooms.

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Anderson, P. M. et al (1987). Teaching the use of metaphor in science writing. unpublished (ERIC AN ED281204)

Gere, A. R. (ed) 1985. Roots in the Sawdust: Writing to Learn Across the Disciplines. National Council of Teachers of English, Urbana, IL.

Perrine, L. (ed.) 1988. Literature: Structure, Sound, and Sense. Harcourt Brace Jovanovich, Publishers. San Diego. A good anthology for finding many poems for using in this project.

Young, A. and Fulwiler, T. (ed) (1986). Writing Across the Disciplines. Boynton/Cook, Publishers. Upper Montclair, NJ.

Appendix I

This project presents a method for integration of creative writing, scientific, and literary interpretations into the science classroom. It also could be easily adapted for applying scientific analysis in the literature classroom. Along this general theme, it utilizes Virginia Department of Education Standards of Learning Program Goals and Objectives in the following relevant areas.

English/Language Arts/Reading Program Goals:

3. Read with understanding for a variety of purposes.
6. Use appropriate language for both formal and informal communication.
7. Use language for creative expression.

Science SOL's

Program Goal I: The science program should be consistent with the intellectual, social, emotional, and physical development of the student.

Objective B2: Provide experiences in science which promote both responsibility and contribution to the group.

Objective C1: Provide multilevel experiences through which each student can meet success, and individual differences can be accepted.

Objective D1: Provide active laboratory and field experiences.

Program Goal II: The science program should be consistent with the nature of science which includes its philosophy, methods of investigation and verification, conceptual organization, and accumulated knowledge.

Objective A: The science program should emphasize skills beginning with basic processes at the elementary level and continuing with the integrated skills at higher grade levels.

Objective B: The science program should develop the overall conceptual themes of science.

Program Goal III: The science program should reflect an involvement with both immediate and future life needs in terms of solving personal and social problems.

Objective B: The science program should emphasize the role of man and science in the natural world.

Program Goal IV: The science program should relate to other curricula areas.

Objective A: Appropriate concepts, processes, values, and skills of other disciplines should be integrated into science.

Appendix II

These are extended questions for the "Design" lesson plan. These questions, and other more extensive questions for all assigned readings, were available to the students through library services in a supplemental study guide designed for the project.

1. Why would the spider choose the heal all plant for a site to make its web ?
2. How did the spider arrive at the plant ?
3. Why did the moth blunder into the web ?
4. What is a spider's web made of ?
5. Is the web permanent ?
6. Does the spider benefit the plant ? Does the moth benefit the plant ?
7. Is there any significance to the white spider being on the white flower ?
8. Is the color of the flower useful in explaining why the moth was there ?
9. Is there any conflict between science and the basic question asked in the last line of the poem ?
10. Have you observed any examples of mimicry as described in the poem ?
11. What type of mimicry does the spider exhibit ? How do you know ? Identify the components.
12. What types of symbiosis are exhibited in the poem ? Identify the components.
13. What types of animal behavior can you infer from the content of the poem ?
14. Propose possible scientific answers (hypotheses) to the questions asked in lines 9-12. Design a possible experimental procedure which could be used to test one of the hypotheses.

Appendix III

The Walden selection incorporates more science/society/technology issues than "Design" and was used as a basis for a field trip to a local pond. It also illustrates a longer non-poetic analysis possibility.

A Sample Lesson Plan

Title: Science as Background Information in Literature

Readings: Thoreau, H.D. "The Pond in Winter" in Walden
Dillard, A. Selections from Pilgrim at Tinker Creek

Focus for Learning: Analyzing, in detail, a literary work or selection from a work for its scientific context, including a discussion of the analogies and conclusions which the author draws from his interpretations of the work.

Direct Teaching Plan:

After the students have read the passage from Walden, lead them in a discussion of the following questions.

1. What types of animal life are present in the pond at this time of year according to the essay ?
2. Compare the attitudes toward ecological conservation between the "wild men" and the naturalist. Can you present evidence of continued existence of such attitudes ?
3. The question of the bottom of the pond is not so remote as you might think. Such attitudes prevail about the lake in Mountain Lake, Virginia. What evidence could you cite which could be used to answer the question of the presence of a bottom without doing the sounding of the pond ?
4. Describe the differences in the two sounding techniques Thoreau describes. Why do you suppose that his was more accurate than the other ?
5. If the pond has a general regularity, and if there is no apparent inlet or outlet of large enough size to account for the volume of the pond, and considering the latitude of the location of Walden Pond, what are some possible causes for its existence ?

Which is most likely ?

6. Thoreau makes an hypothesis, which he tests on White Pond, about his observations and conclusions on Walden Pond's depth versus shape relationship. Describe the hypothesis, the test, and the result.
7. Thoreau's comments on the Laws of Nature are interesting. Locate information on such terms as "the unified field theory" or the "super strings theory" and discuss how they relate to Thoreau's comments.
8. Discuss Thoreau's proposed methods for locating a submerged inlet or outlet. Locate information concerning modern methods for doing the same thing.
9. Do we now have instruments delicate enough to detect the undulations of the earth's crust ? What are they and how do they work ?
10. Discuss the physical and biological factors which could account for the differences in color that Thoreau records for the water in the pond and the ice. Supply biological and physical possibilities.

Checks for Understanding: Informal questions and answers during the discussions of the directed teaching questions can serve as a check for understanding.

Practice Assignment: Students will analyze another work (Dillard's is a good example but need not be the only one used) in the same way they analyzed "The Pond in Winter". They will generate their own questions and answers concerning the selected work.

Summary Activities: Group discussions of the practice assignment will serve as summary activities. Or, students may wish to prepare an essay with Thoreau's as a model in which they discuss their personal experiences with an environmental factor and present it to the class.

Anticipation of Next Activity: In the next activity we shall examine a poem which describes a series of observations in a purely poetic sense. In preparation, read McKeon's "Salmon".

Appendix IV

This reading list illustrates some of the materials available. It is by no means all inclusive. In cooperation with science teachers, English teachers could design lesson plans which incorporate the scientific content into their literature instruction.

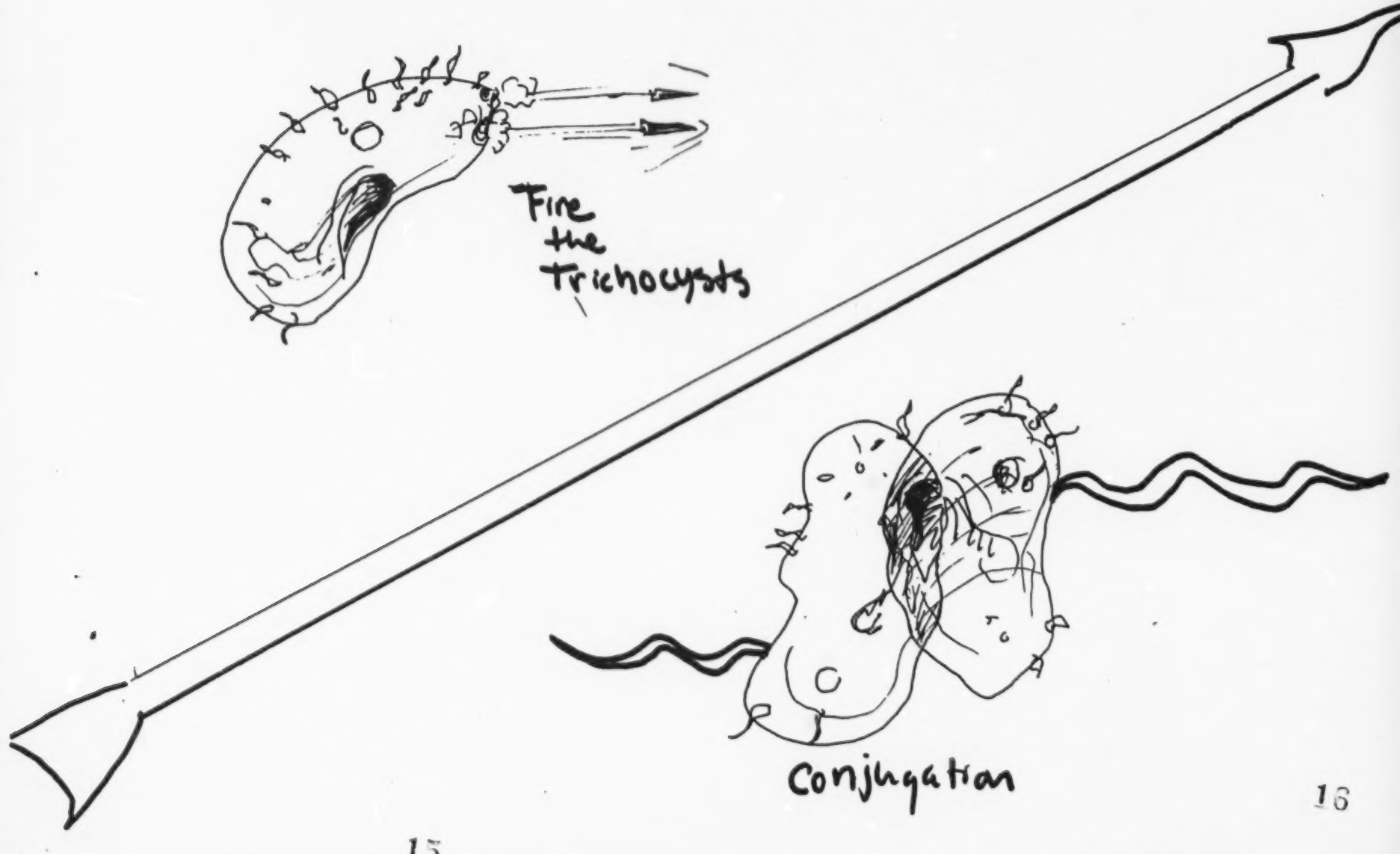
Suggested Reading List

Beveridge, W.I.B.	The Art of Scientific Investigation
Blake, W.	"The Flea" in Perrine
Bradley, S.	The American Tradition in Literature
Bronowski, J.	Science and Human Values
Dickinson, E.	"A hummingbird" in Perrine
Emerson, R.	"Rhodora" in Bradley
Frost, R.	"Design" in Bradley
Gould, S.	"Dr. Down's Syndrome" in The Panda's Thumb
Himes, C.	"The Eve of Meiosis" in Bioscience 15(12):796
McKeon, K.	"Salmon" in Winter Man
Miller, J.	"Self-made Man" in The Body in Question
Miller, J.	"The Pump" in The Body in Question
Perrine, L.	Literature: Sound and Sense
Poe, E.	"Sonnet:to Science" in Bradley
Sagan, C.	Cosmos
Sandburg, C.	"Grass" in Bradley
Thoreau, H.	"The Pond in Winter" in Walden
Unknown	Genesis 30:28-36 in The Holy Bible
Unknown	First Samuel 5-6 in The Holy Bible
Whitman, W.	"I saw in Louisiana an live oak growing" in Bradley
Whitman, W.	"When I heard the learn'd astronomer" in Perrine

and various scientific journals such as "The Journal of the Virginia Academy of Science", "Castanea", "Nature", and such "soft science" publications as "National Geographic", "Scientific American", and "Natural History".

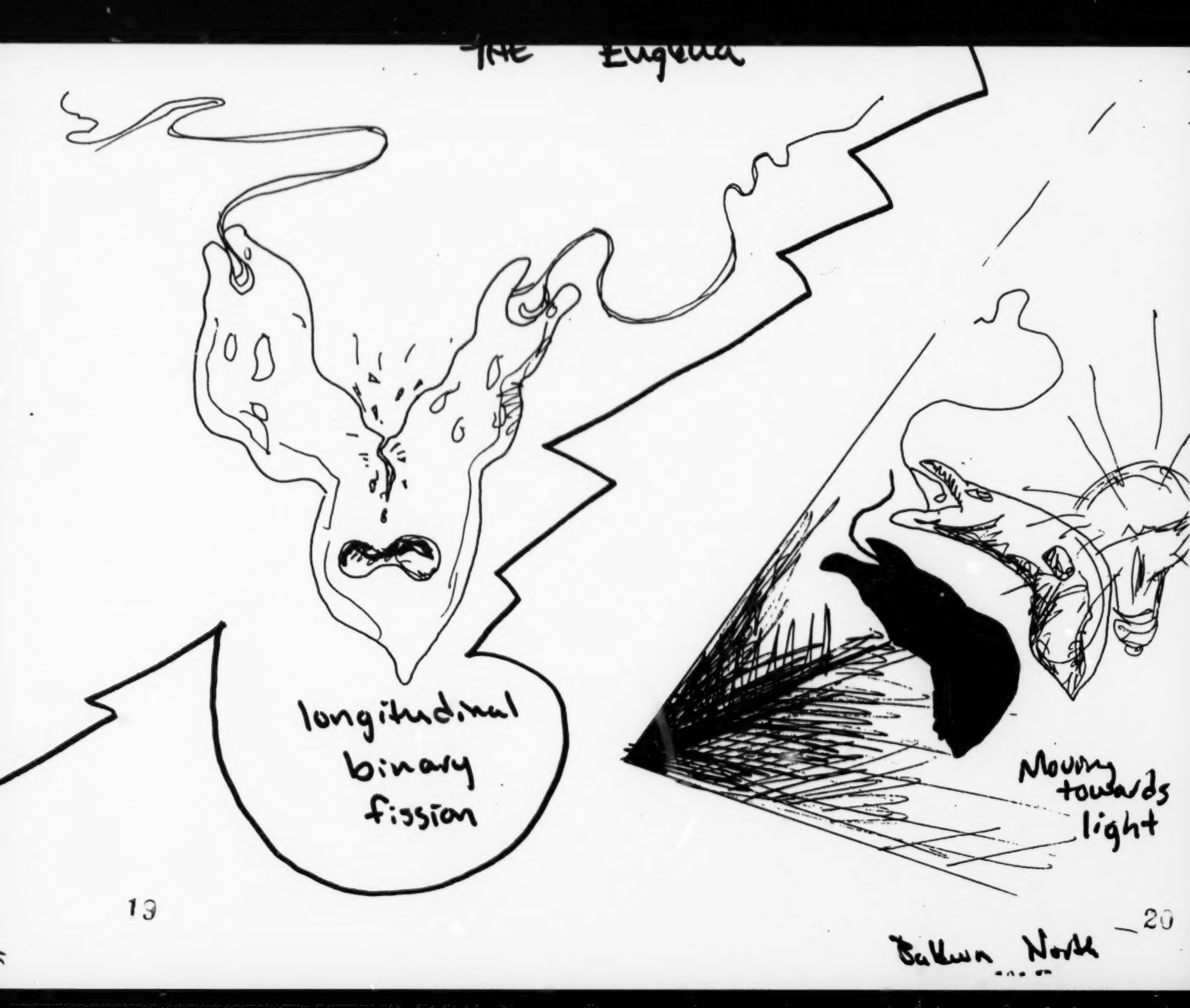
THE Paramecia

Fire the Trichocysts

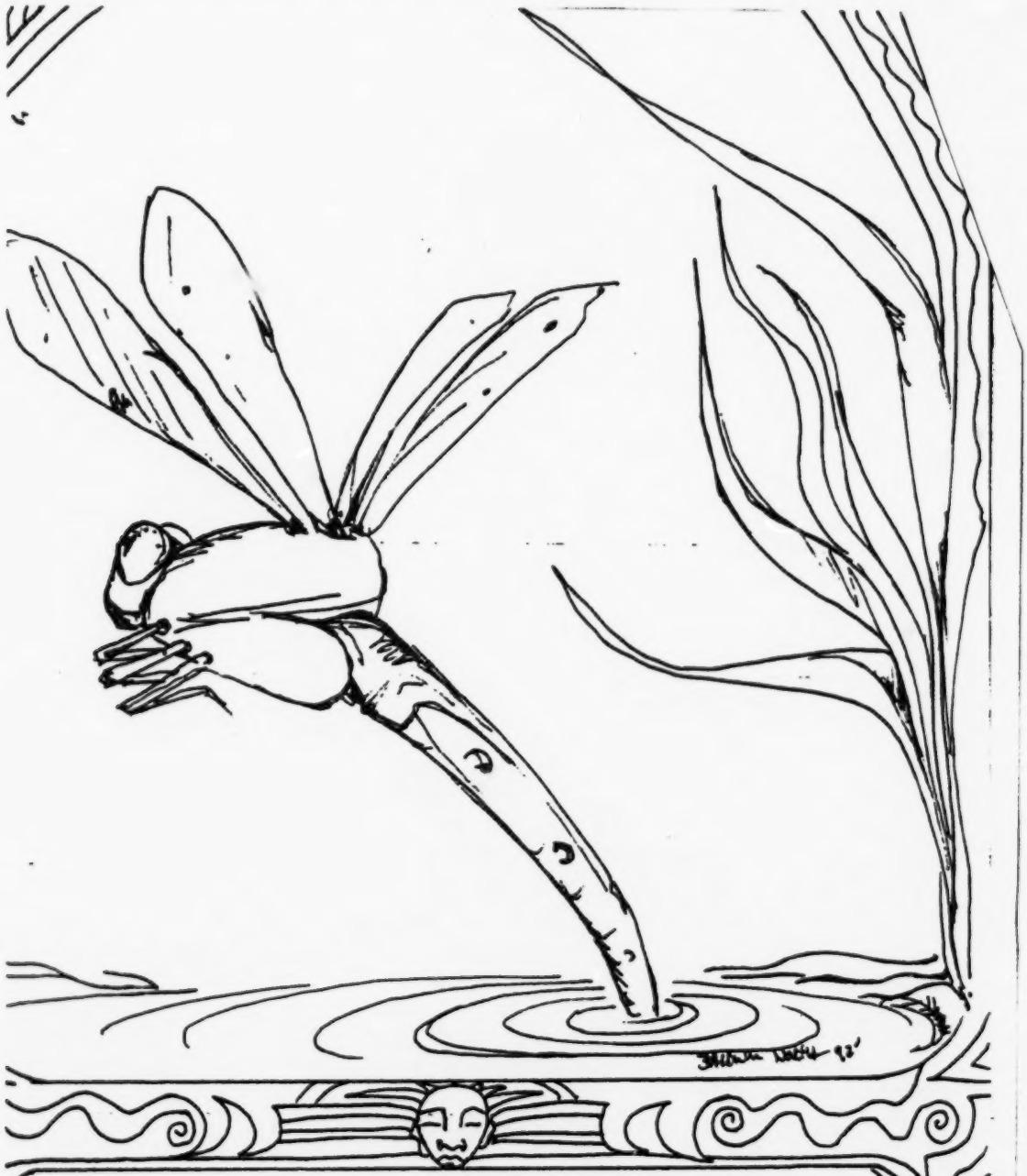


Conjugation

THE Amoebas



Balkwin North



THE Female Dragonfly, Ophiogomphus bison or Western Mountain Gamphid, dipps it's abdomen to wash off it's exposed eggs.

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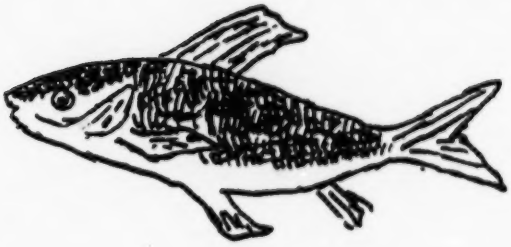

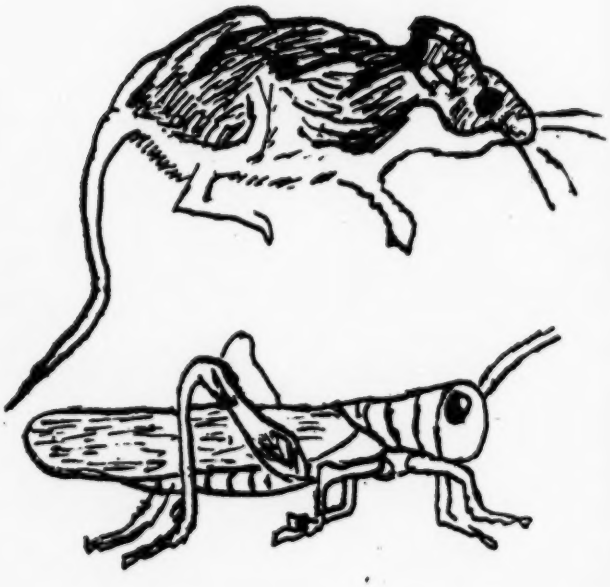

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